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DIFFRACTION OF SOLITARY ELECTRONS FLYING IN INDIAN-FILE FASHION

V. Leshkovtsev

Attribution of wave properties to individual particles (electrons, neutrons, etc.) is a very important concept in quantum mechanics. This concept is based on experiments in the diffraction of particles. Up to now, however, all experiments have been conducted with intensive beams of particles. It was only due to the diffraction's independence of beam intensity that wave properties could be ascribed to particles, by extrapolating this condition back to the individual particles; i.e., diffraction is definitely not the result of some sort of collective interaction of the beam particles with the diffracting object. The "imaginary ideal experiment" on the diffraction of solitary electrons flying one-by-one in Indian file, as it were, is therefore usually considered in quantum mechanics courses. Obviously, carrying out such an experiment has great practical importance.

Recently, such an experiment was carried out by L. Biberman, N. Sushkin, and V. Fabrikant in the Moscow Power-Engineering Institute imeni Molotov (1). For observing diffraction, they used a magnetic electron microscope (2) of the translucent type (EM-100) in which a number of structural charges were made. The pole shoes of the projection lens with their holder were removed, as was the intermediate deflector and two permalloy deflectors of the objective collimator. An additional diaphragm was also installed over the diffracting object. The faradays of the cylinder connected with a mirror-galvanometer (sensitivity $2.7 \cdot 10^{-11}$ amps/division) were determined, and a device was added which permitted the photographic plate to be moved without disturbing the vacuum. Up to 28 photographs were obtained with the same plate by using this device.

The following method was used to measure the intensity of a beam of electrons which was far too weak to be detected by a galvanometer. At first, a beam of electrons was created which was intense enough to be measured by a galvanometer. This beam was captured by a faradic cylinder and the intensity was determined according to the reflection of the galvanometer mirror. Then the faradays of the

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cylinder were drained off, and the beam falling on the plate was expanded, with the aid of a projection lens into a series of spots with gradually increasing (up to 10 centimeter) diameter. Photometric check showed that the density of blackening was identical within the confines of every spot, and therefore the density of electrons for each spot was defined as the quotient of the known beam intensity divided by the area of the spot. A curve of blackening was constructed for each photoplate according to intensity of blackening and electron density. This permitted one to determine the intensity of a beam having an intensity only one fifth of that detectable by a galvanometer. After this, the intensity of the beam was decreased sharply, and the track of the beam was fixed on the plate with the lenses switched off, thus determining the intensity of the weak beam of electrons. A diffracting object, namely small magnesium oxide crystals on collodion film, was placed in the path of the beam and the diffraction picture was obtained. To check the constancy of intensity, the diffracting object was removed after exposure and the track of the beam was again fixed. The diffraction pictures for strong beams were obtained in the usual manner on photographic plates with considerably less sensitivity.

Thus, diffraction pictures were obtained for beams almost seven times different in intensity. They proved to be completely identical. The intensity of the weak beam was measured at $4.2 \cdot 10^3$ electrons per second. Thus, the average time between two passages of electrons in the instrument was equal to $2.4 \cdot 10^{-4}$ seconds. Since the electrons were accelerated to energies of 72 keV, each of them traversed the entire path in the instrument in $8.5 \cdot 10^{-9}$ second; i.e., the transit time was $3 \cdot 10^4$ times less than the interval between two electron hits on the plate. In other words, the motion of electrons in the instrument in obtaining the diffraction picture of a weak beam was as follows: an electron passed through the instrument in $8.5 \cdot 10^{-9}$ second; the instrument was free of electrons for a time interval 30,000 times greater than the latter figure; only after this time interval did a new electron pass through the instrument. It is apparent that, with such a tremendous time interval between consecutive passages, the probability of simultaneous passage of even two electrons is wholly negligible.

This experiment will doubtless enter all courses in quantum mechanics very shortly.

BIBLIOGRAPHY

1. L. Biberman, N. Sushkin, and V. Fabrikant, DAN SSSR, LXVI, 185, 1949

2. N. Sushkin, The Electron Microscope, Gostekhizdat, 1949

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